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July 11, 1944. A. RONNING 2,353,360

MINE SWEEPING AND DISABLING APPARATUS

Filed March 2, 1940 3 Sheets-Sheet 1

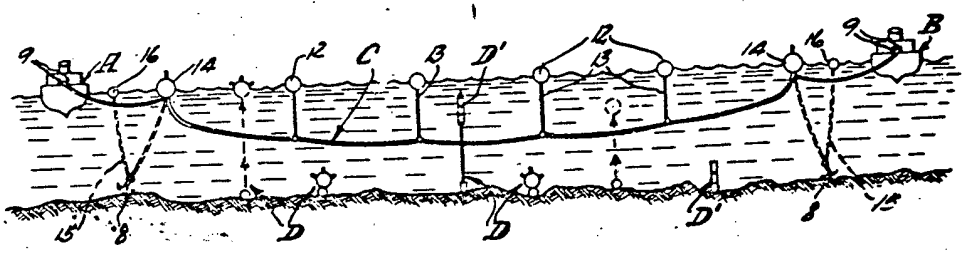

Fig-1-

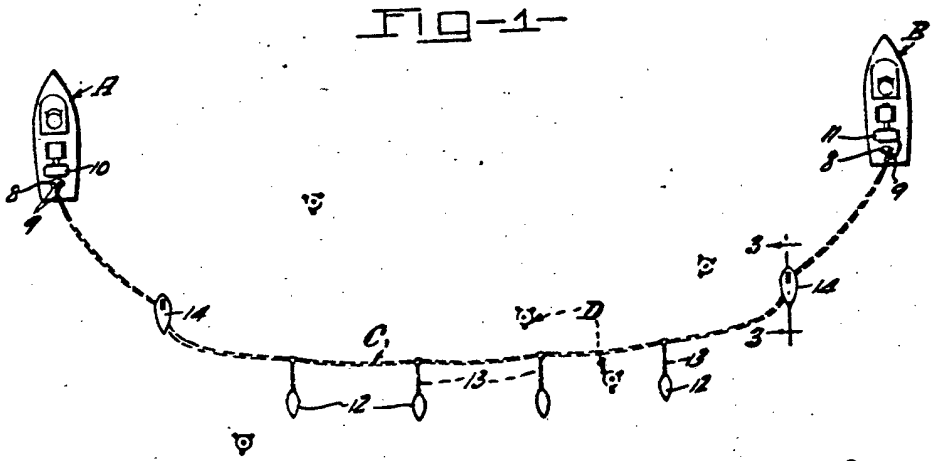

Fig-2-

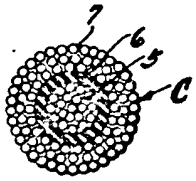

Fig-4-

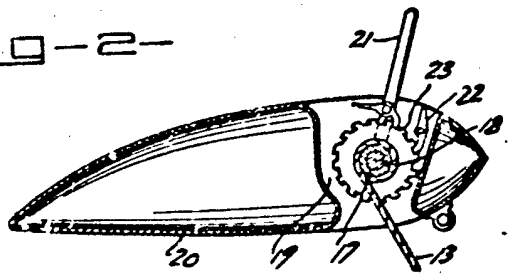

Fig-3-

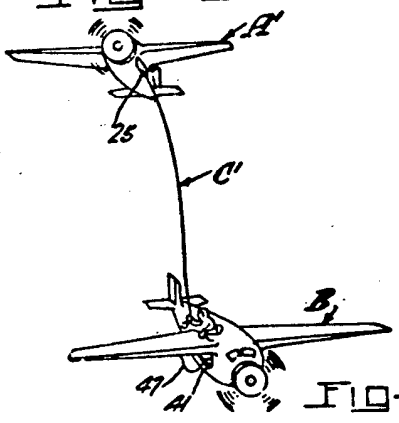

Fig-6-

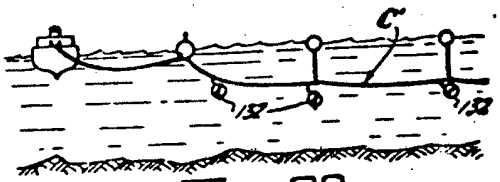

Fig-20-

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July 11, 1944. A. RONNING 2,353,360

MINE SWEEPING AND DISABLING APPARATUS

Filed March 2, 1940 3 Sheets-Sheet 2

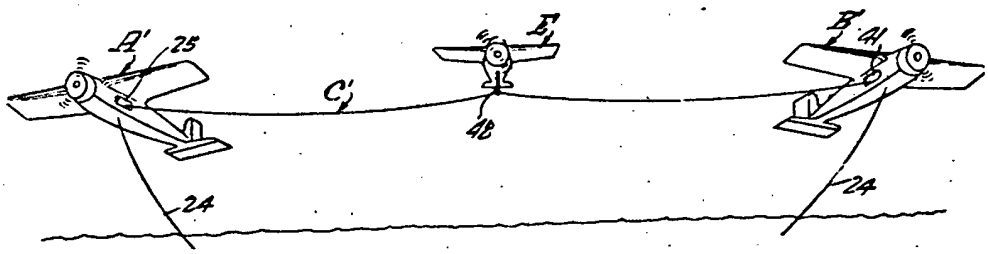

Fig-5-

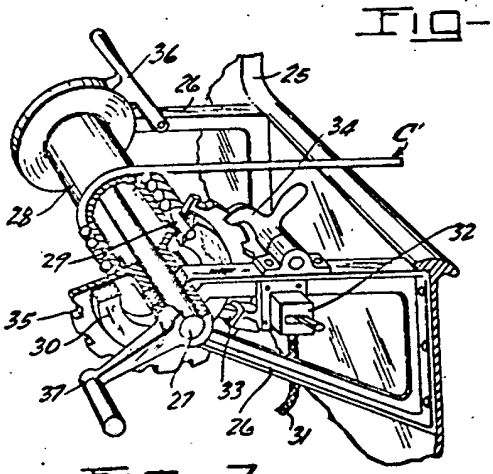

Fig-7-

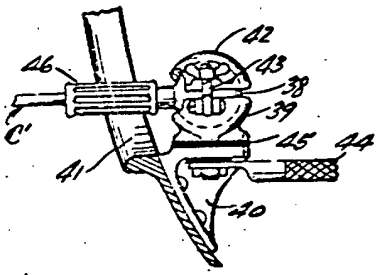

Fig-8-

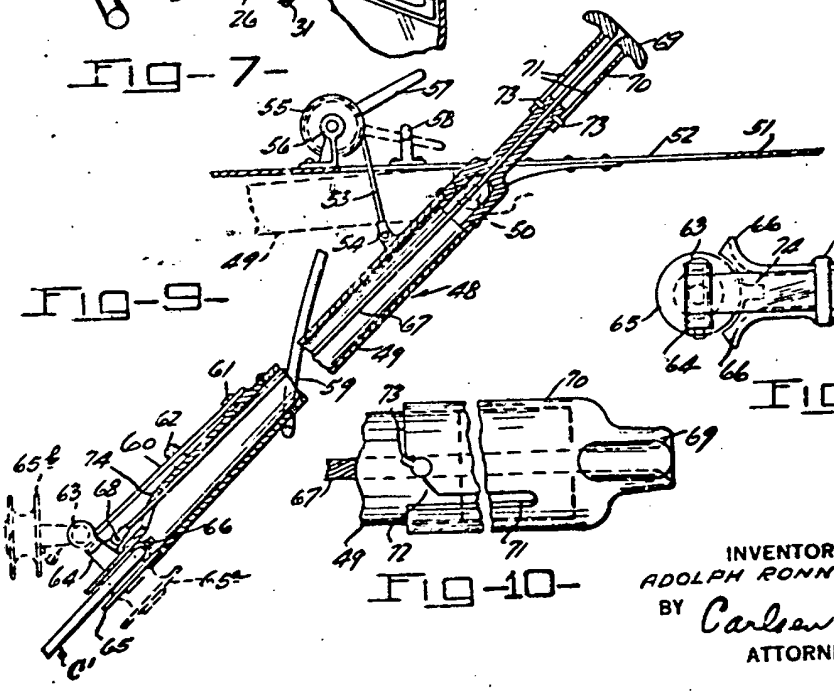

Fig-9-

Fig-11-

Fig-10-

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July 11, 1944. A. RONNING 2,353,360

MINE SWEEPING AND DISABLING APPARATUS

Filed March 2, 1940 3 Sheets-Sheet 3

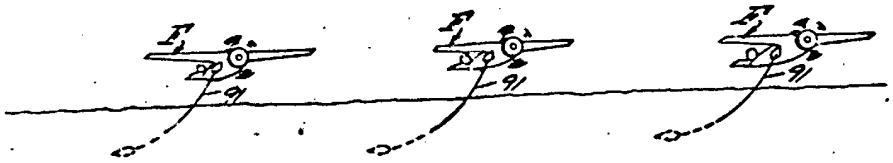

Fig-12-

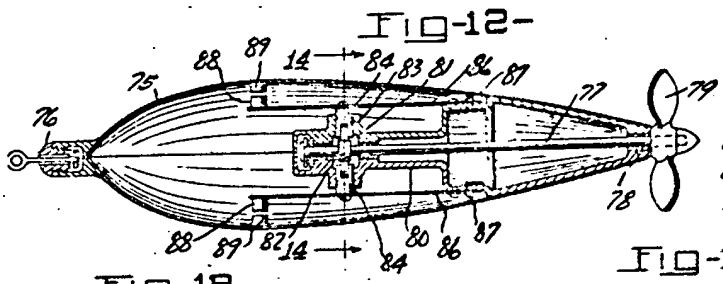

Fig-13-

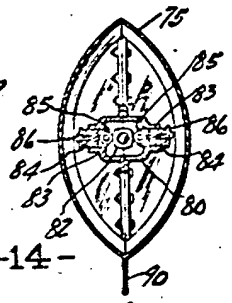

Fig-14-

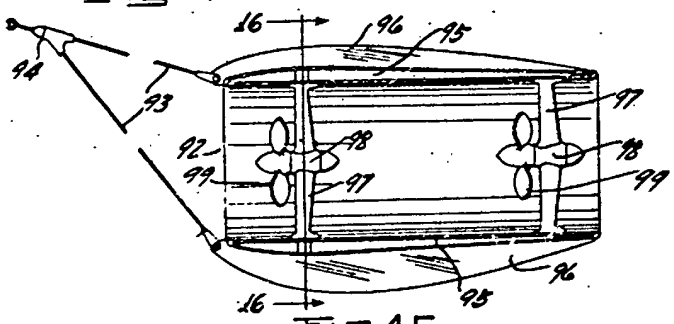

Fig-15-

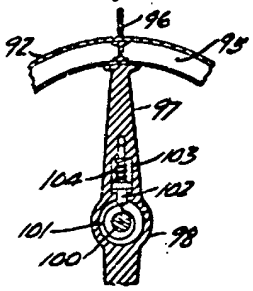

Fig-16-

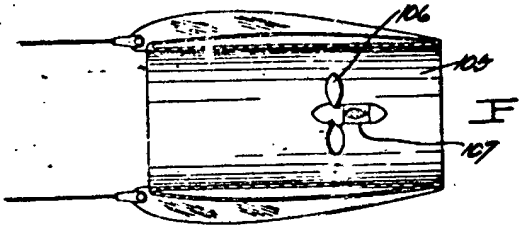

Fig-17-

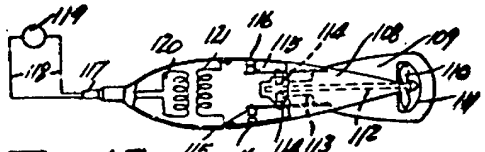

Fig-18-

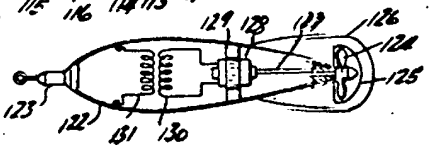

Fig-19-

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Patented July 11, 1944 2,353,360

UNITED STATES PATENT OFFICE

2,353,360

MINE SWEEPING AND DISABLING APPARATUS

Adolph Ronning, Minneapolis, Minn.

Application March 2, 1940, Serial No. 321,655

7 Claims. (Cl. 244—1)

This invention relates to improvements in apparatus for sweeping up and disabling explosive mines such as used to protect areas of the sea against enemy vessels.

The primary object of the invention is to provide a mine sweeping apparatus or rig which will not only sweep up the more usual contact detonated mine, but which will be equally effective in discharging and disabling the types of mines which are detonated by vibratory or magnetic effects in their vicinity.

Another object is to provide a mine sweeping apparatus which may be operated by either surface vessels or boats or by aeroplanes flying above the surface. A further object is to provide means for detonating all types of mines in a small, light, practical form particularly well suited to manipulation from aeroplanes. Still another object is to provide improved mechanism for manipulating mine sweeping apparatus of this kind.

These and other more detailed and specific objects will be disclosed in the course of the following specification, reference being had to the accompanying drawings, in which—

Fig. 1 is a view showing a mine sweeping apparatus of my invention as pulled by boats and in use in the sea to disable mines laid therein.

Fig. 2 is a plan view, parts below the surface of the water being shown in dotted lines.

Fig. 3 is an enlarged section through one of the floats, taken along the line 3—3 in Fig. 2.

Fig. 4 is an enlarged cross section through the flexible sweeping member or cable.

Fig. 5 is a perspective view showing a mine sweeping apparatus operable by several aeroplanes flying near the water.

Fig. 6 is a view showing the manner in which the flexible cable is paid out between the aeroplanes.

Fig. 7 is an enlarged detail view of the reel and feed mechanism for one end of the cable used in Fig. 5.

Fig. 8 is a detail view of the connector for the other end of the cable.

Fig. 9 is an enlarged vertical and longitudinal section through a pickup device used by an aeroplane to support the caster portion of a long span of cable as shown in Fig. 5.

Fig. 10 is an enlarged elevation of an upper part of the pickup device shown in Fig. 9.

Fig. 11 is an enlarged rear elevation of a lower part of the pickup device.

Fig. 12 is a perspective view illustrating the use of several individual mine disabling units.

Fig. 13 is an enlarged horizontal longitudinal section through a unit such as shown in Fig. 12.

Fig. 14 is an enlarged cross section along the line 14—14 in Fig. 13.

Fig. 15 is a view similar to Fig. 13 but showing a different type of disabling unit.

Fig. 16 is an enlarged fragmentary section substantially along the line 16—16 in Fig. 15, but showing only a central and outer portion of the unit.

Fig. 17 is a view similar to Fig. 15, but showing still another modification of the unit.

Fig. 18 is a side elevation, partially in section, of a remotely energized electrically operating disabling unit.

Fig. 19 is a similar view of a self-energized unit.

Fig. 20 is a view similar to a left hand portion of Fig. 1, but showing the sweeping rig with attached detonating units of the types shown in Figs. 13–19.

Referring now more particularly to the drawings, the mine sweeping and disabling apparatus shown in Figs. 1 through 4 is adapted for operation by surface vessels or craft A and B and comprises a cable or flexible current carrying member C which is connected at its ends to the vessels to be pulled thereby through the water. This cable preferably takes the form shown in Fig. 4, comprising a stranded wire core or conductor 5, an insulating sheath 6 of rubber or such material as used in the insulation of submarine cables, and an outer heavy covering 7 of wire to protect said sheath from damage by contact with objects in the sea. At its ends the cable C carries anchors 8 which may be dropped between bitts 9 on the vessels A and B to drag along the cable and the conductor 5 is connected at one end to a heavy duty generator 10 carried on one vessel. At the other end of the cable some current absorption or dissipating device 11, such as an electric welder which is readily available at any time or place, is mounted on the other vessel and connected to conductor 5. The return circuit is made to and through the water and as the generator is operated it will thus be seen that a current will flow through the cable setting up an electromagnetic field in the water thereabout. This action will be sufficient to set off any magnetically detonated mines which may be in the vicinity of the cable as it is dragged through the water, it being presumed of course that the sensitivity of the mines is such that they will be detonated by such means.

In addition the cable C may carry the usual means (not shown) for cutting free the contact detonated mines of more usual form and the

cable used may in fact be the conventional cable rig for the purpose with a sheathed conductor arranged thereon in order to carry the electric currents in accordance with my invention.

A series of mines of different types are designated generally at D in Figs. 1 and 2 and those noted specifically at D are similar to an improved sectional mine construction, employing either, or any, combination of, contact detonators and magnetic or vibratory detonators, such as shown and described in my copending application Serial No. 321,886, filed March 2, 1940, which has matured into Patent No. 2,352,226, issued June 27, 1944.

A series of floats 12 are arranged in spaced relation along the center portion of the cable and are connected thereto by short tie cables or leads 13 to support the cable at substantially an even depth below the surface. The end portions of the cable are provided with (preferably) larger end floats 14 and the anchors 8 may be dropped to the bottom as shown in Fig. 1 to drag down the portion of the cable outwardly of these end floats and allow the entire sweeping rig to be anchored and left standing at any time. Light lines 15 connected to the anchors are provided with marker buoys 16 as a convenience in picking up the anchored ends of the cable and setting it in use again.

The floats 12—14 may be each, or any number thereof, provided as shown in Fig. 3 with a reel 17 for carrying the tie lead 13 or other cable connecting means. This reel is journaled by its axle 18 in a transverse opening 19 of the hollow body 20 of the float and a ratchet lever 21 is provided for rotating the reel to draw up the lead. The lead may be extended by releasing the latch dog 22 from the toothed ratchet wheel 23 carried by the reel.

It will be evident that the apparatus as thus far described may be used to simultaneously sweep up the contact detonated mines in the usual manner while exploding and rendering harmless any magnetically or electrically detonated mines which may be in the vicinity. It will thus be possible to clear a lane in the sea of all danger by a single trip thereacross with my apparatus.

The vessels A and B are of course preferably of wooden construction so that they themselves will not set off the magnetic mines.

It is contemplated that, the sensitivity of the magnetically detonated mines being sufficient, the cable or wire for setting up the energizing or detonating magnetic field might well be carried above the surface of the water, as shown in Fig. 5. Here the cable is shown at C' and the ends thereof are carried by aeroplanes or aircraft A' and B' with a third aeroplane E to support a center part of the cable, if desired or necessary. One plane, as that shown at A', may then carry the generator and the other the current absorption or dissipating (both not shown) device while the return circuit is made to the water by trailing "ground" wires shown at 24.

The aeroplane A' carrying the generator (of course this may be connected at either end of the cable) is provided within the cable opening 25 with brackets 26 which support the axle 27 of a reel 28 for the cable. One end 29 of the cable is secured to, and electrically connected with, a metal ring 30 carried on the reel and the wire 31 from the generator is run through a control switch 32 to a brush 33 bearing on this ring to thus connect the generator to the cable C' under control of the switch. A latch dog 34 engages ratchet teeth 35 formed in one end of the reel 28 to lock the cable at any extended length while a brake lever 36 frictionally engages the other end of the reel to prevent overrunning of the reel as the cable is unwound. A crank 37 is mounted on the reel axle 27 for reeling in the cable.

The other end of the cable C' carries a ball or knob 38 electrically connected therewith, and the aircraft B' carrying the current dissipating device is provided with a socket 39 mounted on a bracket 40 inwardly of the side opening 41. Said socket has a hinged cap 42 to enclose and engage the knob 38 and retain the same by screwing down the pivoted wing screw 43, and the bracket is connected by a wire 44 to the said dissipating device (not shown). An insulating bushing 45 insulates the bracket from the aircraft body and a handle 46 on the cable facilitates its insertion and connection with the socket 39.

In passing out the cable C' at the outset of operations the aeroplane A' flies over the aeroplane B', as shown in Fig. 6, and pays out the cable until it may be grasped by the pilot below and pulled around the wing (a short rope 47 may be used for this purpose) and connected with the socket 39. The cable is then pulled out to the condition shown in Fig. 5, the ground wires 24 are dropped and the cable is carried over the area desired to be cleared of the magnetic mines.

The aircraft E carries a pickup device designated generally at 48 and which is used to pick up and engage a center part of the cable C' after the same has been pulled out to the desired length. This device shown in detail in Figs. 9–11 comprises a tubular housing 49 which is pivotally attached at an upper end portion to a bracket 50 on the underside of the aeroplane fuselage 51 and projects at an upper end into the fuselage through an opening 52. When not in use the tubular member is swung upwardly beneath the fuselage as shown in the dotted lines, and when in use is lowered to a downwardly and rearwardly trailing position. For this purpose a flexible line 53 is connected at 54 to the housing and is wound over a reel 55 journaled in brackets 56 within the fuselage. A handle 57 on this reel may be used to unwind or rewind the line and may be locked by engagement with the hook 58 as clearly shown. A U-shaped loop 59 is supported below the fuselage to embrace and limit the downward movement of the pickup device.

Adjacent the lower end of the housing 49 and on the rear side thereof a flat leaf spring or carrier strip 60 is secured at 61 to the housing and extends downwardly therefrom within a traversing cross rib 62. At the lower extremity the spring 60 is formed to receive the hinge pin 63 by means of which the hub 64 of a pulley 65 is pivotally supported. Normally the spring 60 is tensioned to move forwardly and so present the pulley 65 forwardly of the housing 49 as shown in the dotted line position 65a in Fig. 9, and in this position the pickup device when carried forward against the cable C' will guide the cable downwardly into the groove of the pulley. The tension is then sufficient to carry the spring 60 back until the pulley moves directly beneath the downwardly and transversely flaring guide portions 66 of the housing 49 which thus retain the cable in engagement with the pulley but permit free endwise movement of said cable.

An elongated, slightly flexible operating member or rod 67 is extended through the bore of the

housing 49 and at its lower end is pivotally connected at 66 with the hub 64 of the pulley forwardly of the hinge pin 63. At the upper end the member 67 is pivotally mounted and retained in the head 69 of a tubular cap 70 which slidably and rotatably fits over the upper end of the housing. This cap has slots 71 in opposite sides flaring outwardly at lower ends 72 to engage radially projecting pins 73 carried by the housing and the arrangement is thus such that, by rotating and adjusting the cap up and down on the housing, the member 67 may be reciprocated correspondingly in the housing. When pulled upward as shown the pulley 65 is held in cable engaging position, but when the member 67 is moved downwardly it will swing the pulley hub backwardly and upwardly to carry the pulley rearwardly and drop the cable therefrom. This position is shown in dotted lines 65b in Fig. 9. The rear wall of the housing 49 may be slotted as shown at 74 to provide more clearance for the member 67 as it flexes in this operation of the pulley. All operations of thus picking up the cable and dropping it when finished may be carried out from within the aircraft and without interference with the normal duties of the pilot.

Referring more particularly to Figs. 12 through 19, I also provide what may be termed individual mine detonating units or trolls which may be operated singly or in a series by a single aircraft or surface vessel.

The device shown in Figs. 13 and 14 comprises a hollow streamlined body unit or housing 75 having a swivel 76 at its forward end for the connection of a towing line or cable. A propeller shaft 77 is journaled longitudinally and axially in the housing and projects rearwardly through a bearing 78 for connection thereto of a propeller 79. A large bearing assembly 80, extended forwardly from its connection and mounting in the rear end of the housing 75, supports the forward end of the propeller shaft 77 and has a recess 81 within which the shaft carries a cane 82. Radially extended guides 83 in said bearing assembly 80 slidably support plungers 84 having rollers 85 contacting the cam 82 and at outer ends these plungers are connected to longitudinally extended spring arms 86. The rear ends of the arms 86 are secured at 87 to the bearing and the forward ends carry hammers 88 on outer sides and adjacent to anvil blocks 89 secured to the walls of the housing 75. A guide fin 90 on the housing prevents rotation thereof in the water.

This unit is pulled through the water, by means of tow cables 91 connected either to aircraft F as shown in Fig. 12, or by surface vessels of any kind. The propeller 79 is turned rapidly by action of the water and the cam 82 on the propeller shaft 77 thus rapidly thrusts the plungers 84 outward causing the hammers 88 on the arms 86 to sharply strike the anvil blocks 89. This action sets up a vibration around the path of the unit which will effect and detonate any adjacent mines of the type using vibration responsive detonators such as those described in my copending application hereinbefore identified. It will be evident that several of these units may be pulled through an area of the water infested by mines and they will effectively render the mines harmless to shipping. The units may be operated either singly or in tandem formation by each pulling craft.

Figs. 15 and 16 illustrate still a different form of vibratory unit which comprises a tubular or cylindrical housing 92 open at both front and rear ends and having a bridle 93 and swivel 94 for the towing cable. The wall of the housing is preferably hollow as indicated at 95 and the housing is prevented from itself turning or spinning in the water by guide vanes 96.

Diametrically extending spokes or spiders 97 in the housing adjacent front and rear ends thereof have central journals 98 for the propellers 99, the axles 100 of which carry cams 101 within said journals as best seen in Fig. 16. Plungers 102 are slidably mounted in radially extended recesses 103 in the spokes and are urged forcefully against the cams 101 by coil springs 104. As this unit is pulled through the water the rotation of the propeller 99 will actuate the plungers 102 to set up a pounding action which, transmitted through the spokes 97 to the hollow walls of the unit, will cause a very considerable vibration in the adjacent water. This of course will detonate any vibration responsive mines in the vicinity.

Fig. 17 shows a similar mechanism, but here the housing 105, similar in shape, design and operation to that just described, has only a single propeller 106 suported by the diametrical spoke 107 and provided of course with the vibration causing cam and plunger mechanism not shown. The spoke 107 in this case is shown as horizontally extended, whereas the spokes 97 of Figs. 15 and 16 are vertically extended.

The unit shown in Fig. 18 is similar to that in Fig. 13, but additionally includes means for detonating magnetic mines. The housing 108 has rearwardly extending guide vanes 109 and the propeller 110 operates in an opening 111 in said vanes. The propeller shaft 112 is journaled forwardly in a bearing housing 113 and has cam mechanism, designated generally at 114 and identical to that previously described, for vibrating the hammers 115 against the anvil blocks 116 and setting up vibrations in the water to explode vibration responsive mines in the vicinity. The tow cable 117 in this case carries two wires 118 which carry current from a generator 119, arranged in the towing craft or vessel, to the primary 120 of a transformer arranged in the housing 108. The secondary 121 of said transformer is connected to the housing and serves to set up a magnetic field about the unit to thereby also discharge magnetic mines in the vicinity.

The unit shown in Fig. 19 also includes a housing 122 with a forward swivel connection 123 for the tow line. The propeller 124 operates in an opening 125 in the guide vanes 126, but in this case the shaft 127 turns a generator 128 supported by brackets 129 in the housing. The output of this generator is carried to the primary 130 of a transformer in the housing and the secondary 131 thereof is "grounded" in order to set up the mine detonating magnetic field as the device is towed through the water. Obviously this self generating unit might also be provided with vibration producing mechanism if so desired.

Fig. 20 shows a section of the mine sweeping rig of Figs. 1 and 2 with the cable C' thereof provided at intervals with individual detonating units or trolls 132 which may be any of the forms shown in Figs. 13 through 19. The rig when thus equipped will be effective for disabling all types of mines whether they use contact, magnetic or vibration responsive detonators, as will be evident. Likewise individual detonating units may be attached to the wires 24 in the sweeping apparatus of Fig. 5, if so desired.

It is understood that suitable modifications may be made in the structure as disclosed, provided such modifications come within the spirit and scope of the appended claims. Having now therefore fully illustrated and described my invention, what I claim to be new and desire to protect by Letters Patent is:

1. An apparatus for disabling magnetic mines, comprising an electrically conducting cable adapted to be suspended at its ends between two aircraft and to be carried in a stretched out condition therebetween and in a substantially horizontal plane above the mines, means in one aircraft connected to one end of the cable for electrically charging the same and to thereby set up a magnetic field about the cable, means in the other aircraft connected to the other end of the cable for dissipating such electrical charge, and grounding wires connected to said charging and dissipating means for completing the connections therebetween, said grounding wires being trailed from the respective aircraft.

2. Apparatus for disabling magnetically detonated mines, comprising a cable adapted to be suspended at its ends between two aircraft flying parallel courses over the water and to be carried thereby in a substantially horizontal plane above the mines in the water, a generator in one aircraft connected to one end of the cable, a current dissipating device in the other aircraft connected to the other end of the cable, a grounding wire connected to the generator and arranged to trail from the aircraft into the water, and another grounding wire connected to said current dissipating device and adapted to trail from the other aircraft in the water whereby a circuit will be completed to cause the flow of current through the cable, through the grounding wires and through the water between the wires to thereby establish a magnetic field sufficient to detonate magnetic mines in the vicinity.

3. Apparatus for disabling magnetically detonated mines, comprising a cable adapted to be suspended at its ends between two aircraft flying parallel courses over the water and to be carried thereby in a substantially horizontal plane above the mines in the water, a generator in one aircraft connected to one end of the cable, a current dissipating device in the other aircraft connected to the other end of the cable, a grounding wire connected to the generator and arranged to trail from the aircraft into the water, another grounding wire connected to said current dissipating device and adapted to trail from the other aircraft in the water whereby a circuit will be completed to cause the flow of current through the cable, through the grounding wires and through the water between the wires to thereby establish a magnetic field sufficient to detonate magnetic mines in the vicinity, the said cable being of considerable length to extend the magnetic field across a wide path in the water, and means carried by a third aircraft for supportably engaging a center portion of the cable to relieve the cable of excessive sag.

4. Apparatus for disabling mines of the type detonated by electromagnetic disturbances in the vicinity, comprising in combination, an electrically conducting cable adapted to be suspended between two aircraft and to be carried thereby over the mines, and means for inducing an electrical current flow along the cable to establish a electro-magnetic field about the cable and for detonating mines in the vicintiy of which the cable is passed.

5. The method of sweeping an area of water to harmlessly detonate any magnetic mines which may be present and render said area safe for the passage of a ship thereover which comprises: first calculating the residual magnetism of said ship, suspending a cable between two carrier ships, passing an electric current through said cable to induce a magnetic field equivalent to said calculated residual magnetism, and moving said carrier ships over said area while said current is passing through said cable with the cable beneath the surface of said water.

6. The method of sweeping an area of water to harmlessly detonate any magnetic mines which may be present and render said area safe for the passage of a ship thereover which comprises: first calculating the residual magnetism of said ship, inducing a magnetic field equivalent to said calculated residual magnetism by passing an electric current through a cable, and then moving said cable over the area to be swept.

7. The method of sweeping an area of water to harmlessly detonate any magnetic mines which may be present and render said area safe for the passage of a ship thereover which comprises: first calculating the residual magnetism of said ship, inducing a magnetic field equivalent to said calculated residual magnetism by passing an electric current through a cable, and then moving said cable over the area to be swept, at the same time accurately guiding the movement of said cable from each end thereof.

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